Report from the Airplane Performance Harmonization Working Group

Issue: Accounting for the effect of snow, slush, standing water, and ice-covered runways on takeoff performance (with all-engine accountability)

Rule Section: FAR 121.189, FAR 135.379/JAR-OPS 1.485, 1.490

Introduction

This report recognizes the safety benefit of requiring accountability for contaminated runways. The position of this report is that the costs of harmonizing to engine-out accountability far outweigh the safety benefits, evidenced by the historical safety record. All-engine accountability provides an acceptable balance between the theoretical enhancement to safety that engine-out accountability on contaminated runways provides, and the significant cost to industry that it would impose.

The Terms of Reference for the Working Group, set out in WP1-1 make it clear that the focus of the HWG was to resolve the competitive and economic issues that were raised by different performance rules between Europe and the United States and read, in part:

> "HARMONIZATION TERMS OF REFERENCE
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> TITLE OF INITIATIVE: Airplane Performance Operating Limitations
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> STATEMENT OF ISSUE: European and U.S. air carriers operating identical airplanes at a common airport are, currently, subject to different performance operating rules. Although all conditions and equipment are alike, application of the applicable FAR/JAR may result in different load capabilities. Therefore, the Airplane Performance Harmonization Working Group (PERF HWG) objectives are:
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> 1. Review FAA and JAA airplane operational performance requirements (FAR 121/FAR 135/JAR-OPS and develop a list of differences between the two sets of requirements. (Use should be made of preliminary work on the task carried out by industry). During this review, if differences are identified in the associated certification requirements, such differences should be reported to the Aviation Rulemaking Advisory Committee (ARAC) and the HMT by the FAA and JAA contacts;
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> 2. When the first step is complete, explore the feasibility of harmonization of each identified difference in the following order of priority: Performance Class A, Class B, and Class C;
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> 3. Within one year of the publication of the ARAC task in the Federal Register, develop recommendations for common (harmonized) operational performance requirements for those items identified under item 2 above as being feasible for harmonization. If the HWG determines FAA rulemaking is required, that determination must be forwarded to the FAA for consideration of rulemaking priority, resource allocation, and additional tasking to ARAC, as appropriate.
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> …"

1 – What is the underlying safety issue to be addressed by the FAR/JAR? [Explain the underlying safety rationale for the requirement. Why should the requirement exist? What prompted this rulemaking activity (e.g., new technology, service history, etc.)?]

For the past 40 years there has been no uniform FAR requirement for considering the effect of runway contaminants on takeoff runway length requirements. Despite the lack of a uniform requirement, many operators have adopted methods for adjusting their maximum allowable takeoff weight for contaminated runway conditions: Some have applied adjustments for the effect of degraded acceleration using all-engine performance, while others have applied adjustments for both degraded acceleration and degraded deceleration with engine-out stop accountability. It is unknown if there are some airlines that do not made any adjustments for the effects of contaminated runway conditions.

Compared to a dry (or wet) runway, snow, slush, or standing water can reduce an airplane's acceleration capability due to the drag caused by the tires running through the contaminant (displacing it), and by the impingement of the contaminant spray on the airplane. The reduction in acceleration capability results in a requirement for a longer distance to accelerate to lift-off for a given takeoff weight. Alternatively, the takeoff weight can be reduced to adjust the acceleration capability to the runway length available.

The presence of a runway contaminant will also reduce the capability of the airplane to stop (compared to the dry runway case) in the event of a rejected takeoff. The traditional consideration has been to account for the accelerate-stop on a dry runway surface due to an engine failure at the critical point, and the stop to be initiated by the V1 speed. More recently the engine-out accelerate-stop criteria for new certifications was extended to wet runways as well.

The need to consider stopping capability (i.e. a rejected takeoff (RTO) due to an engine failure) on a contaminated runway was introduced into the harmonization discussion by the JAR-OPS 1 requirement to account for engine failure for all takeoffs using a single V1 (Go/No Go) speed. <u>There is no service history demonstrating engine failure/RTO accountability will benefit public safety for takeoffs from contaminated runways.</u>

Both all-engine and engine-out considerations necessitate a reduction in limit weight for a takeoff from a contaminated runway. For the worst of the contaminated runway conditions (1/2 inch slush or standing water), the weight offload for the engine-out consideration can be considerably greater than for the all-engine consideration. In example 1 section 5 item 7 - Performance Penalties the all-engine penalty would result in a 300 lb. offload, while engine-out penalty would result in a 12,480 lb. offload, 41.6 times as great as the all-engine case. In rare instances, the engine-out consideration can reduce the payload capability so severely that flights may be canceled. The present record of incidents and accidents does not justify the extreme penalties that would be imposed by a mandatory requirement for engine out accountability.

Imposing a requirement for engine out accountability may very well have a *negative* effect on safety. In a perfect world, a clear and clean runway requirement would be mandated at all airports with snow and slush. However if we accept the fact that this is a desirable, but unattainable standard, it must be considered that some passengers, at least on cancelled short-haul flights, will seek other modes of transportation.

Air travel by both major and commuter airlines is significantly safer than traveling by road and a switch to road would result in additional road accidents, injuries and deaths. Estimates of the comparative safety in the U.S. state that "automobile travel remains far more dangerous, at least 30 times so in terms of death rates per mile traveled, than air travel by all scheduled (large and commuter) airlines"[1]

2 - What are the current FAR and JAR standards relative to this subject? [Reproduce the FAR and JAR rules text as indicated below.]

Current FAR text:

Currently, the Part 121/135 operating rules do not specifically require that runway surface contamination in the form of ice, snow, slush, or standing water be taken into account in determining allowable takeoff weights. FAA Advisory Circular 91-6A provides information, guidelines, and recommendations for conducting turbojet operations on runways covered by water, snow, or slush. It does not prescribe a methodology to follow in developing contaminated runway advisory data. It does include sample data presentations for all-engine and engine-inoperative cases.

Part 121

FAR 121.189 Airplanes: Turbine engine powered: Takeoff limitations.

(e) In determining maximum weights, minimum distances, and flight paths under paragraphs (a) through (d) of this section, correction must be made for the runway to be used, the elevation of the airport, the effective runway gradient, the ambient temperature and wind component at the time of takeoff, and, if operating limitations exist for the minimum distances required for takeoff from wet runways, the runway surface condition **(dry or wet)**. Wet runway distances associated with grooved or porous friction course runways, if provided in the Airplane Flight Manual, may be used only for runways that are grooved or treated with a porous friction course (PFC) overlay, and that the operator determines are designed, constructed, and maintained in a manner acceptable to the Administrator. [Emphasis added].

Part 135

[1] *Discussion on Ending the Free Airplane Rides of Infants: A Myopic Method of Saving Lives*, by R.B. McKenzie and D.R. Lee, Cato Institute Briefing Paper No. 11 Aug 30 1990.

FAR 135.379 Large transport category airplanes: Turbine engine powered: Takeoff limitations.

(e) In determining maximum weights, minimum distances, and flight paths under paragraphs (a) through (d) of this section, correction must be made for the runway to be used, the elevation of the airport, the effective runway gradient, the ambient temperature and wind component at the time of takeoff, and, if operating limitations exist for the minimum distances required for takeoff from wet runways, the runway surface condition **(dry or wet).** Wet runway distances associated with grooved or porous friction course runways, if provided in the Airplane Flight Manual, may be used only for runways that are grooved or treated with a porous friction course (PFC) overlay, and that the operator determines are designed, constructed, and maintained in a manner acceptable to the Administrator. [Emphasis added].

Current JAR text:

JAR-OPS 1.485 General

(a) An operator shall ensure that, for determining compliance with the requirements of this subpart, the approved performance data in the Aeroplane Flight Manual is supplemented as necessary with other data acceptable to the Authority if the approved performance data in the Aeroplane Flight Manual is insufficient in respect of items such as:

(1) Accounting for reasonably expected adverse operating conditions such as take-off and landing on contaminated runways; and

(2) Consideration of engine failure in all flight phases.

(b) An operator shall ensure that, for the **wet and contaminated** runway case, performance data determined in accordance with JAR 25X1591 or equivalent acceptable to the Authority is used. (See IEM OPS 1.485(b).).

JAR-OPS 1.490 Take-off

(b) An operator must meet the following requirements when determining the maximum permitted take-off mass:

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(5) On a wet or contaminated runway, the takeoff mass must not exceed that permitted for a take-off on a dry runway under the same conditions.

(c) When showing compliance with sub-paragraph (b) above, an operator must take account of the following:

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(3) The runway surface condition and the type of runway surface (see IEM OPS 1.490(c)(3));

2a – If no FAR or JAR standard exists, what means have been used to ensure this safety issue is addressed? [Reproduce text from issue papers, special conditions, policy, certification action items, etc., that have been used relative to this issue]

There is no current FAR standard for operations from contaminated runways. Many operators have voluntarily adopted manufacturers advisory data. FAA Advisory Circular 91-6A provides guidance material however, there is no mandatory requirement to account for contaminated runways (see Part 3, below).

3 - What are the differences in the FAA and JAA standards or policy and what do these differences result in? [Explain the differences in the standards or policy, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]

Currently, FAR 121/135 operating rules do not specifically require that runway surface contamination in the form of ice, snow, slush, or standing water be taken into account in determining allowable takeoff weights. FAA Advisory Circular 91-6A provides information, guidelines, and recommendations for conducting turbojet operations on runways covered by water, snow, or slush, <u>but it does not provide a uniform methodology</u> to follow in developing contaminated runway data. It does include sample data presentations for both all-engine and engine-inoperative cases.

In contrast to the FAA requirements, JAR-OPS 1 requires runway surface contamination and engine failure to be taken into account in determining allowable takeoff weights for all Performance Class A airplanes used in commercial air transportation. (Performance Class A airplanes include multi-engine turboprop airplanes with a maximum approved passenger seating configuration of more than 9 seats or a maximum takeoff mass exceeding 5700 kilograms, and all multi-engine turbojet powered airplanes.) In addition, JAR-OPS 1 requires operators to ensure that the contaminated runway data being used has been developed in accordance with criteria provided in AMJ25X1591, or equivalent.

A number of North American operators have made it clear that movement to the JAA standard would impose significant financial hardship on their operations, without a compensating enhancement to safety. Examples which follow (see part 5, below) will illustrate the potentially huge reductions in payload that could be imposed on the U. S. commercial aviation industry. In some cases operations may have to be cancelled with all the attendant inconvenience to passengers, lost revenue, and cost that would entail; all for no demonstrated enhancement to the safety of current operations.

At no time during the Working Group's deliberations was there any suggestion that the safety record for either trading partner was superior to the other's. Discussions on safety therefore tended to focus on each individual rule's potential to enhance safety, against the cost to implement that rule. The differences between the proposed engine-out and all-engine rules amounts to a *theoretical* enhancement to safety that has not been borne out by an examination of the available safety data (see part 5, below).

4 - What, if any, are the differences in the current means of compliance? [Provide a brief explanation of any differences in the current compliance criteria or methodology (e.g., issue papers), including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]

The FAR does not contain a standard for takeoff performance limitations from contaminated runways, so there is no applicable means of compliance. Guidance published by the FAA in AC 91-6A for operations on contaminated surfaces differs from the compliance criteria used by the JAA in that it does not provide a specific methodology for determining an airplane's takeoff performance on contaminated surfaces, nor does it mandate engine out accountability.

5 – What is the proposed action? [Describe the new proposed requirement, or the proposed change to the existing requirement, as applicable. Is the proposed action to introduce a new standard, or to take some other action? Explain what action is being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen for each proposed action.]

The Performance Harmonization Working Group agreed that specific FAR Standards need to be created to account for the performance effects of a takeoff on a contaminated runway. The Working Group however did not reach consensus on the all-engine/engine-out issue for takeoffs from contaminated runways. Therefore, the working group is submitting two different reports regarding rulemaking proposals for this issue. This report proposes adopting contaminated runway takeoff limitations into the FAR that would include all-engine accountability. The other report proposes harmonizing on the JAR standard, which includes accountability for engine failure.

The performance effects of contaminated runways are severe, and the economic impact can be significant. Takeoff weight is most severely restricted by an engine-out accountability consideration, which can lead to a large reduction in passengers and cargo. In some cases, operations would no longer be economically viable. Some members of the working group considered the resulting economic penalty to be too large in relation to the potential safety benefit to recommend harmonization to the JAA requirements.

The working group investigated the potential for reducing the engine-out accountability economic penalty, including data analysis, presentation, and performance calculation methods, differentiation of contaminant types, depths, and frequency of occurrence, and runway clearing and condition reporting practices. Two subgroups were formed to examine each of these issues and report to the working group. The subgroups' conclusions regarding each of these issues are provided separately, but the end result was that there was little likelihood of significantly reducing the economic burden associated with accounting for the effects of contaminated runways on takeoff performance when engine failure accountability is included. The complete report from each of the sub-groups is attached[2].

The following considerations support the recommendations contained in this report:

1. Service History

Statistics presented in the Takeoff Safety Training Aid, developed jointly by the aviation industry and the FAA in 1992, and supplemented by Boeing in 2000 (Boeing *Aero* Magazine, July 2000) show that 9% of the rejected takeoff overrun accidents/incidents for which runway conditions were reported occurred on contaminated runways. Runway conditions were not reported for 29 percent of the rejected takeoff accidents in the database. [This data base includes all western built jet aircraft with a maximum gross weight greater than 60,000 lbs and does not include commuter airline operations.] There are no accurate records of how many takeoffs are made from contaminated runways. The Working Group Report 4 suggests that since 9% of RTO accidents occurred on contaminated runways, the exposure is greater (on contaminated runways), since it is probably accurate to assume that less than 9% of operations are from contaminated runways. However, when these events (eight overrun accidents) are reviewed in greater detail, it is shown that in seven of the events, the RTO was initiated after V1. Engine failure was a factor in only one of these seven events. There was no stop initiation speed reported in the eighth event. Engine failure was a factor in only one event and that event was one of the seven where the reject speed was reported to be greater than V1. There has been only one engine failure RTO <u>overrun</u> incident/accident reported during takeoff from a contaminated runway (out of a total of 365,951,330 takeoffs through 1999). <u>Thus, there is not even one event in this data base for the entire 40 years of service history of commercial jet operation in the Western World where there has been an RTO overrun accident where the RTO was known to have been initiated before or at V1 (whether due to engine failure or other reasons) and the runway conditions were reported as snow, ice or slush</u>. Imposing engine-out performance standards would not have prevented any of the known accidents/incidents for takeoffs from contaminated runways.

2. Probability

The low probability of an engine failure occurring during the time period that could possibly prevent the airplane from either taking off or stopping on the runway, justify consideration of using all-engine accountability. The exposure time period can be zero for a light weight takeoff from a long runway or up to 10 seconds for a takeoff weight limited by runway length.

3. Exposure to Contaminants

[2] See Contaminated Runway Subgroup 1 Report (WP 13-22), and Contaminated Runway Subgroup 2 Report(WP 10-4)

Of the different types of surface contaminants, slush and standing water cause the largest performance penalties. Although slush conditions are infrequent, when slush is present, it may be impractical to " wait until tomorrow". Waiting causes flight delays that are spread throughout the system that cause significant economic penalties to the operator, and distress to the traveling public. For example, flights cancelled or delayed in Chicago owing to slush can cause delays or cancellations of flights out of Washington.

4. Negative Effect on Domestic Operations

<u>While harmonization with JAR-OPS standards would "level the playing field' for International FAR/JAR competitors, uniform application would adversely impact many US domestic or North American services where there are no FAR/JAR competitive issues</u>. A uniform all-engine standard would "level the playing field" between FAR operators, since the FAR does not currently specify a uniform method for accounting for contaminated runway conditions.

5. Operating Environment

The operating environment of US and Canadian operators is seen as being significantly different than that of European operators, as far as contaminated runway operations are concerned. Implementation of engine-out slush accountability has not caused a significant financial hardship for European operators. The authors of this report believe that:

- There is less infrastructure in North America to support treating runways (sanding) or cleaning to a "black" condition.
- There are more "remote" services needed in the northern US, Canada and Alaska than in Europe.
- There are fewer train or road alternatives in North America than in Europe.
- In North America there are longer distances to travel by road than in Europe if that is the only alternative.

6. Performance Data Availability

Data available today for operators to use to show compliance with the proposed harmonized requirements accounting for an engine failure is based on standards and assumptions that varied over the years and varied between manufacturers. If engine-out accountability were mandated for FAA operators, the magnitude of the variation in existing data would demand that data be re-done to a new standard to minimize economic impact. This is a substantial task and the cost would be borne by the traveler.

7. Performance Penalties

In situations where the airplane is normally operated near its dry runway field length limit weight, the required takeoff weight reduction for runway contaminant, especially slush, can be significant. An example of the approximate takeoff weight reduction required is provided in the table below.

Takeoff Weight Reduction with Slush Penalties - %

Model	All-Engines ¼ Inch	Engine-Out ¼ Inch	All-Engines ½ Inch	Engine-Out ½ Inch
737-200	5%	16%	10%	23%
767-300	0	13%	3%	17%
747-400	0	10%	0	13%

Such penalties can impose severe economic hardship on the operator since a full passenger payload may only represent 10 % of the takeoff weight for a design range mission.

In general, the highest economic penalties associated with engine-out accountability would accrue to operations that are runway length limited on a dry runway. For example a wide variety of operations would be affected by the requirement to move from all-engines data on ½ inch of slush, to engine-out accountability.

Example 1 – Domestic Flight

On a 727-200 flight[3] from Washington National to Cincinnati (454 nautical miles), where there is no contamination, the aircraft could easily operate with a full passenger load of 145 passengers and 1,500 lbs. of freight. On the same flight with ½ inch of slush on the runway at takeoff, the aircraft could operate with 145 passengers and 1,200 lbs. freight using all-engines accountability, but only 97 passengers using engine-out accountability.

Example 2 – International Flight

Accountability would also impact longer-haul flights. For example, on a B767-300 flight[4] from JFK to Tel Aviv (4626 Nautical Miles), where there is no contamination, the aircraft could operate with a full passenger load of 233 and 14,000 lbs. of freight. On the

[3] B727-200, Runway 01 (6,869 Ft.), zero wind, JT8D-9 engines, 25 degrees flap, 32 degrees F, 60 minutes reserve fuel, typical passenger configuration 20F/125Y.
[4] B767-300, Runway 13R (14,572 Ft.), zero wind, PW4060 engines, 5 degrees flap, 32 degrees F, International reserve fuel, typical passenger configuration 30F/203Y.

same flight with ½ inch of slush on the runway at takeoff, the aircraft could operate with no loss of payload using all-engines accountability, but only 150 passengers and no freight using engine-out accountability.

Example 3 – Domestic Transcon Flight

On a domestic B757-200 flight[5] from Washington National to LAX, where there is no contamination, the aircraft could operate with a full passenger load of 180 and 5,300 lbs freight. On the same flight with ½ inch of slush on the runway at takeoff, the aircraft could operate with 158 passengers using all-engines accountability, but only 64 passengers using engine-out accountability.

8. Commuter Operations

The effect of snow, slush and standing water on smaller jet (i.e commuter) airplanes, is disproportionately higher than on larger airplanes because of smaller tires and more significant impingement of the contaminant on the airframe. The contaminant performance adjustments due to drag can be so high, with engine failure accountability, that the aircraft can no longer be operated economically. Smaller airplanes represent a very large fleet of airplanes in the U.S. and Canada, and do not compete directly with European operators. The adoption of engine-out requirements in the interest of harmonization will impose severe operating limitations on commuter airline operators that do not operate in a competitive situation where harmonization has competitive implications for our trading partners. Thus, requiring engine failure accountability for slush and standing water will seriously curtail commuter airline service without affecting the competitiveness between U. S. and European operators.

9. Airport Issues

Central to the debate concerning contaminated runway accountability is the ability of the airport operator to remove contaminants and provide a timely and accurate report of runway surface condition to dispatch and flight crews in need of that information. It was clear to everyone on the Working Group that these issues were key to reaching consensus on the accountability issue. The survey results, available as WP 10-4, and set out in Appendix B, made it clear that:

1. The ability of airport operators to remove snow in a timely manner seems to vary according to the equipment and personnel available. To reduce down-time, operators claimed that they need more of both;
2. Most airports strive for a “black runway” condition. However, lead time required for snow removal varied considerably, and could radically affect the levels of contaminant on the runway before removal operations could begin;

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[5] B757-200, Runway 01 (6,869 Ft.), zero wind, PW2037 engines, 15 degrees flap, 32 degrees F, 60 minutes reserve fuel, typical passenger configuration 22F/158Y.

3. Reports on contamination depth and condition take place on an irregular basis and depths of contaminant may vary considerably depending on the location that the measurement was taken. Generally measurements taken by the airport operator are not precise enough to make their use by flight crews reliable from an aircraft performance perspective;
4. Contaminant depth may vary along the length of one runway;
5. Flight load planning usually takes place 1-1 ½ hours prior to push-back. The conditions which exist during the take-off roll, which may occur 5-30 minutes later than push-back (possibly due to a long taxi, line-ups, or de-icing) may not resemble the reported contamination at the time that critical planning takes place;
6. Flight Crews as a rule, must make a final assessment of the contamination at the runway threshold immediately prior to take-off, frequently without the benefit of accurate and up-to-date contaminant reporting from the airport operator;
7. The “trigger” to begin snow removal at airports varies considerably, and could be any where from a one-half an inch, to two inches of contaminant.
8. Most airports have runway friction testing equipment, but the airport operators do not fully understand the impact of contaminants on airplane take-off performance. Most of the emphasis from an airports perspective seems to be on landing issues.

In short, there is very little consistency in contaminant removal and runway condition standards across airports in Canada and the U.S. The tools for airport operators and air operators to measure and communicate the information to flight crews in a timely way are not available today.

At present, Airport Operators do not consider AC 150/5200-30A any more than simply guidance. Until the FAA regulates the condition of runways as a function of safety, we will continue to operate in winter with widely varying runway conditions. This is not the consistent level of safety we all desire, and puts extreme pressure on operators and pilots to operate when exact runway performance cannot be guaranteed. The FAA should update the requirements of FAR 139.313 to require that runways, including runway ends, high-speed turnoffs, and taxiways (consistent with the AC, and where the highest number of departures occur), be maintained in a “no worse than wet” condition. Only then will Airport Operators aggressively seek the tools, methods, and cooperation they need with all parties to enhance the safety of winter operations.[6]

These concerns extend to prospective all-engines standards or engine-out regulatory standards. Another ARAC Working Group should be tasked with an examination of runway surface reporting and clearing criteria.

[6] Appendix B of this report

For each proposed change from the existing standard, answer the following questions:

6 - What should the revised standard be? [Insert the proposed text of the revised standard here]

Part 121

FAR 121.189 Transport category airplanes: Turbine engine powered; takeoff limitations.

(c) No person operating a turbine engine powered transport category airplane certificated after August 29, 1959 (SR422B), may take off that airplane at a weight greater than that at which compliance with the following may be shown:

(1) The accelerate-stop distance must not exceed the length of the runway plus the length of any stopway.

(2) The takeoff distance must not exceed the length of the runway plus the length of any clearway except that the length of any clearway included must not be greater than one-half the length of the runway.

(3) The takeoff run must not be greater than the length of the runway.

(4) For runways that are dry or wet, the same value of V1 must be used to show compliance with paragraphs (c)(1) through (c)(3) of this section. For contaminated runways, V Stop must be used to show compliance with paragraph (c)(1) of this section.

[Note: The definitions of accelerate-stop distance, takeoff distance and takeoff run currently in FAR Part 25 will need to be modified to recognize that contaminated runway performance is based only on all-engines operating.]

(5) On a wet or contaminated runway, the takeoff weight must not exceed that permitted on a dry runway under the same conditions.

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(d) In determining maximum weights, minimum distances and flight paths under paragraphs (a) through (d) of this section, correction must be made for:

(1) The pressure altitude at the airport;

(2) The ambient temperature at the airport;

(3) The runway surface condition (dry, wet or contaminated), and the type of runway surface (paved or unpaved).

(4) The runway slope in the direction of takeoff; and

(5) Wind, including not more than 50 percent of the reported headwind component and not less than 150 percent of the reported tailwind component; and

(6) The loss, if any, of takeoff run available, takeoff distance available, and accelerate-stop distance available due to aligning the airplane on the runway prior to takeoff.

Part 135

FAR 135.379 Large transport category airplanes: Turbine engine powered; Takeoff limitations.

(c) No person operating a turbine engine powered large transport category airplane certificated after August 29, 1959 (SR422B), may take off that airplane at a weight greater than that at which compliance with the following may be shown:

(1) The accelerate-stop distance must not exceed the length of the runway plus the length of any stopway.

(2) The takeoff distance must not exceed the length of the runway plus the length of any clearway except that the length of any clearway included must not be greater than one-half the length of the runway.

(3) The takeoff run must not be greater than the length of the runway.

(4) For dry and wet runways, the same value of V1 must be used to show compliance with paragraphs (c)(1) through (c)(3) of this section.

[Note: The definitions of accelerate-stop distance, takeoff distance and takeoff run currently in FAR Part 25 will need to be modified to recognize that contaminated runway performance is based only on all-engines operating.]

(5) On a wet or contaminated runway, the takeoff weight must not exceed that permitted on a dry runway under the same conditions.

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(d) In determining maximum weights, minimum distances and flight paths under paragraphs (a) through (d) of this section, correction must be made for-

(1) The pressure altitude at the airport;

(2) The ambient temperature at the airport;

(3) The runway surface condition (dry, wet or contaminated) and the type of runway surface (paved or unpaved).

(4) The runway slope in the direction of takeoff; and

(5) Wind, including not more than 50 percent of the reported headwind component and not less than 150 percent of the reported tailwind component; and

(6) The loss, if any, of takeoff run available, takeoff distance available, and accelerate-stop distance available due to aligning the airplane on the runway prior to takeoff.

Summary of Proposed Changes:

[Note: The proposed changes discussed below include more than just the changes associated directly with the issue of contaminated runway takeoff performance. This was done for completeness and clarity due to the many changes being proposed for the rule sections that address takeoff limitations. Therefore, some of the proposed changes described below will either be repeated or more fully explained in other working group reports.]

<u>(1) Amend §§ 121.189(c) and 135.379(c) to remove the words "listed in the Airplane Flight Manual."</u> Currently, §§ 121.189(c) and 135.379(c) require that the Airplane Flight Manual (AFM) must be used to determine the maximum takeoff weight for which compliance is shown with the field length requirements of those sections. As noted in Working Group Report 1, for most of the new performance requirements being proposed by the Performance Harmonization Working Group (e.g., runway alignment distance, retroactive application of wet runway requirements, contaminated runway requirements), airplane performance data not currently furnished in AFM's will be needed in order to show compliance. While the working group recommends that the subject of AFM data requirements be further investigated by a working group tasked with such Part 25 issues, the working group recommends proceeding with this rulemaking without waiting for that task to be completed. Until that task is completed, operators should be able to show compliance to the proposed contaminated runway takeoff limitations using supplementary data acceptable to the regulatory authority.

Removing the words "listed in the Airplane Flight Manual" from §§ 121.189(c) and 135.379(c) would leave the proposed §§ 121.173(a) and 135.363(a) (as proposed in a Working Group Report 1), respectively, as the applicable requirements regarding the source of data for showing compliance with §§ 121.189(c) and 135.379(c). The proposed §§ 121.173(a) and 135.363(a) state that the performance data in the Airplane Flight Manual, supplemented as necessary with other data acceptable to the Administrator, applies in determining compliance with §§ 121.175 through 121.197 and §§ 135.365 through 135.387, respectively.

<u>(2)Amend §§ 121.189(c) and 135.379(c) to add the words "for the runway to be used" to clarify that compliance with this requirement must be shown for the runway to be used.</u> This is a clarifying change only.

<u>(3) Amend §§ 121.189 (c)(1), (c)(2) and (c)(3) and §§ 135.379(c)(1), (c)(2), and (c)(3) to use the terms "accelerate-stop distance available," "takeoff distance available" and</u>

"takeoff run available," which would be defined in the proposed new §§ 121.173(i) and § 135.363(i). (See Working Group Report 1 for proposed accompanying amendments to §§ 121.173 and 135.363). This change would harmonize the wording of the JAR and the FAR standards, but would not change the requirement.

(4) Add, as a new §§ 121.189(c)(4) and new §§ 135.379(c)(4), a requirement for dry and wet runways that the same value of V_1 must be used to show compliance with the accelerate-stop, takeoff run, and takeoff distance limitations, and a V_{Stop} be defined for contaminated runways. This requirement would ensure that, on a dry or wet runway, from a single defined go/no-go point (i.e. the V_1 speed), the takeoff can either be safely completed, or the airplane can be brought to a stop within the remaining distance available for stopping the airplane. With the addition of the proposed takeoff limitations for operations from contaminated runways, the concept of V_{Stop} is introduced, which will ensure that the airplane can be brought to a stop within the remaining distance available.

(5) Add new §§ 121.189(c)(5) and 135.379(c)(5) to require that the takeoff weight on a wet or contaminated runway not exceed the takeoff weight permitted on a dry runway under the same conditions. It would be inappropriate, from safety standpoint, to allow a higher maximum takeoff weight from a wet or contaminated runway than from a dry runway under otherwise identical conditions.

(6) Reformat §§ 121.189(e) and 135.379(e) to list, in separate sub-paragraphs, each of the items for which correction must be made. Currently, §§ 121.189(e) and 135.379(e) require correction made to the maximum weights, minimum distances, and flight paths under paragraphs §§ 121.189(a) through (d) and §§ 135.379(a) through (d), respectively, for the runway to be used, the elevation of the airport, the effective runway gradient, the ambient temperature and wind component at the time of takeoff, and, if operating limitations exist for the minimum distances required for takeoff from wet runways, the runway surface condition (dry or wet). Sections 121.189(e) and 135.379(e) also state that wet runway distances associated with grooved or porous friction course runways, if provided in the Airplane Flight Manual, may be used only for runways that are grooved or treated with a porous friction course (PFC) overlay, and that the operator determines are designed, constructed, and maintained in a manner acceptable to the Administrator.

Under this proposal, §§ 121.189(e) and 135.379(e) would be revised to state, "In determining maximum weights, minimum distances and flight paths under paragraphs (a) through (d) of this section, correction must be made for–." "The pressure altitude at the airport" would be listed in new §§ 121.189(e)(1) and 135.379(e)(1). The use of pressure altitude instead of elevation is consistent with changes being proposed throughout this subpart. It reflects the practice that the determination of takeoff weights are normally done on the basis of pressure altitude, and that the Airplane Flight Manual performance information is provided as a function of pressure altitude. New §§ 121.189(e)(2) and 135.379(e)(2) would list "the runway surface condition (dry, wet, or contaminated) and the type of runway surface (paved or unpaved)." This change would add contaminated runway surfaces to the list of runway surface conditions for which correction must be made. It would also add a requirement to correct for the type of runway surface (paved or unpaved). This new requirement is intended to ensure that the applicable takeoff limitations for approved operations on unpaved runway surfaces, such as grass or gravel runways, are based on performance data appropriate to the type of runway surface.

New §§ 121.189(e)(3) and 135.379(e)(3) would list "The runway slope in the direction of takeoff." This item is currently listed in §§ 121.189(e) and 135.379(e) as "the effective runway gradient." The wording change would harmonize the wording with that of the JAR standard and is not intended to change the requirement in any way.

New §§ 121.189(e)(4) and 135.379(e)(4) would list "Wind, including not more than 50 percent of the reported headwind component and not less than 150 percent of the reported tailwind component." This would replace the criterion, "wind component at the time of takeoff," currently listed in §§ 121.189(e) and 135.379(e). The proposed wording is intended to clarify that the total wind (i.e., wind speed and direction), not just the headwind or tailwind component, must be considered. For corrections to takeoff distances, only the headwind or tailwind component is relevant. However, for flight path considerations, the total wind must be taken into account. (Note: This issue is addressed in Working Group Report 6.)

The proposed wording also includes the factors applied to the headwind and tailwind components ("not more than 50 percent of the reported headwind component and not less than 150 percent of the reported tailwind component") that are currently required by the airworthiness type certification requirements of part 25. The working group proposes that these wind factors should be applied to all operations conducted under §§ 121.189 and 135.379, regardless of the certification basis of the airplane.

New §§ 121.189(e)(5) and 135.379(e)(5) would list the new requirement proposed in Working Group Report 3, "The loss, if any, of takeoff run available, takeoff distance available, and accelerate-stop distance available due to aligning the airplane on the runway prior to takeoff." (See that working group report for the reasons for this change.)

7 - How does this proposed standard address the underlying safety issue? (identified under #1)? [Explain how the proposed standard ensures that the underlying safety issue is taken care of.]

The proposed standard addresses the safety issues by requiring FAA operators to take into account the effect of decreased acceleration capability for takeoffs from contaminated runways for all turbine powered airplanes operated under Parts 121 or 135.

Takeoff performance based on all-engines operating throughout the takeoff, does lead to an exposure period of up to ten seconds, such that the airplane would be unable to safely complete the takeoff or complete the stop <u>if</u> power were lost from the critical engine during this period of time. In this situation, the maximum speed from which the airplane could be brought to a stop on the runway would be lower than the minimum speed from which the airplane could takeoff and reach a height of 15 feet over the end of the runway. However, there is no evidence in 40 years of in-service experience that an engine failure during this exposure period has ever occurred.

In addition there is the question of what information to provide to the pilot if takeoff limitations were based on all-engines operating throughout the takeoff. Currently, pilots are provided with a V_1 speed, which is defined as “the maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance [and] the minimum speed in the takeoff, following a failure of the critical engine at V_{EF}, at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance.” The V_1 concept would not be valid for takeoffs in which an engine failure is not taken into account. However, a maximum “stop” speed would be provided, which would be the maximum speed from which the airplane could be stopped on the runway. This would be a departure from what pilots are accustomed to for typical day-in day-out operations, but appropriate training should overcome this issue.

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The proposed standard would increase the level of safety relative to the current FAR. It would codify a requirement to account for contaminated runways.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. [Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

Industry practice varies across the FAA regulated operators. Some operators do not account for contaminated runways. Some operators already take contaminated runways into account with all-engine weight adjustments. Others use engine failure accountability when determining maximum takeoff weights. For those operators who currently do not account for contaminated runways, the proposed standard would increase their level of safety. For those operators already using all-engine adjustments, the proposed standard would maintain the existing level of safety. Operators currently using engine-out adjustments could choose to continue their company practice.

Consideration must be given to other changes in regulations that will be forthcoming from this ARAC Working Group. Agreement to harmonization on the use of runway alignment distance has been achieved by this ARAC Working Group. Nine of the 14

ATA carriers surveyed do not at present account for alignment distance.[7] Acceptance of this regulation at considerable cost to the operators would enhance safety for all runway conditions; dry, wet or contaminated.

10 - What other options have been considered and why were they not selected? [Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.) Include the pros and cons associated with each alternative.]

The alternatives would be to harmonize to the FAR standard (i.e. no accountability for contaminated runways), or harmonize on the JAR-OPS requirement that contaminated runways be accounted for on an engine-out basis. The first option was not selected because there was a consensus that a standard needed to be developed to address an identified safety risk. The second option was not recommended because there is no evidence in the historical service experience database that engine failure accountability would have prevented even one RTO overrun, and because the cost to implement it is substantial.

11 - Who would be affected by the proposed change? [Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]

Operators of transport category airplanes could be affected by the proposed change because they may have to carry out additional analyses for takeoffs from contaminated runways and may realize a loss in revenue if the payload must be reduced or certain operations curtailed in order to comply with the contaminated runway requirements. Manufacturers of transport category airplanes could be affected because they develop the data to perform the contaminated runway analysis. However, some data has already been generated by some manufactures.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? [Does any existing advisory material include substantive requirements that should be contained in the regulation? This may occur because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

None.

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? [Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided. Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

Advisory material, in the form of an AC, should be developed to provide guidelines and an acceptable means of compliance with the proposed standard for taking into account the

[7] See Appendix A for FAA/JAA HARMONIZATION REVENUE LOSSES (WP 13-2)

effects of contaminated runways on takeoff performance. The advisory material should allow maximum use of existing data, thus minimizing the need for developing new data. The means of compliance should include the following criteria to determine data acceptability:

1. The performance methodology for determining the effects of the contaminant on airplane acceleration parameters should be based on industry standard methods.

2. For airplanes currently in use or airplanes of existing approved designs that will be manufactured in the future, the contaminated runway performance information need not be furnished in the Airplane Flight Manual. This information would be considered supplementary data under the proposed revision to §§ 121.171(a) and 135.363(a). [Another ARAC working group should be tasked with determining whether the airworthiness type certification requirements should be amended to require contaminated runway performance information to be included in the AFM. That working group should also be tasked with identifying and addressing any airworthiness type certification criteria associated with determining contaminated runway performance.]

3. Takeoff distance should be based on a 35-foot screen height.

4. Performance credit may be taken for the use of available reverse thrust.

14 - How does the proposed standard compare to the current ICAO standard?
[Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]

ICAO Annex 6 (Operation of Aircraft), Chapter 5, 5.2.6 states, "In applying the Standards of this chapter, account shall be taken of all factors that significantly affect the performance of the aeroplane (such as: mass, operating procedures, the pressure-altitude appropriate to the elevation of the aerodrome, temperature, wind, runway gradient and condition of runway, i.e. presence of slush, water and/or ice, for landplanes, water surface condition for seaplanes). Such factors shall be taken into account directly as operational parameters or indirectly by means of allowances or margins, which may be provided in the scheduling of performance data or in the comprehensive and detailed code of performance in accordance with which the aeroplane is being operated."

The current FAR does not comply with this ICAO standard in that the FAR does not require the runway condition, in terms of the presence of slush, water and/or ice to be taken into account for the scheduling of takeoff performance data. The proposed standard would bring the FAR closer to compliance with the ICAO standard by requiring the effect of slush, standing water, snow or ice on the runway to be taken into account.

ICAO Annex 6, Paragraph 5.2.8 states that "The aeroplane shall be able, in the event of a critical power-unit failing at any point in the take-off, either to discontinue the take-off and stop within the accelerate-stop distance available, or to continue the take-off and clear all obstacles along the flight path by an adequate margin until the aeroplane is in position to comply with 5.2.9." The current FAR does not comply with this ICAO standard for contaminated runway operations. The proposed standard would not bring the FAR into compliance.

15 - Does the proposed standard affect other HWGs? [Indicate whether the proposed standar should be reviewed by other harmonization working groups and why]

No.

16 - What is the cost impact of complying with the proposed standard? [Please provide information that will assist in estimating the change in cost (either positive or negative) of the proposed rule. For example, if new tests or designs are required, what is known with respect to the testing or engineering costs? If new equipment is required, what can be reported relative to purchase, installation, and maintenance costs? In contrast, if the proposed rule relieves industry of testing or other costs, please provide any known estimate of costs.]

The proposed standard would carry with it additional costs for operators and manufacturers.

A standard for developing all-engines data needs to be created. Manufacturers would have to create new data to meet that standard, since the existing all-engines data is not to a consistent standard. Boeing would have to generate data to address the V_{Stop} issues arising from this proposal. Airbus does not produce any all-engines data, and would be obliged to generate new all-engines data. The non-recurring cost to the industry to generate data to a uniform standard, to support all-engines accountability has been estimated to be roughly $24M. By comparison, the cost to develop engine-out data to a uniform data standard would be comparable.

For those operators who currently use all-engine accountability for contaminated runways, there would be no additional cost. However, by comparison, the cost of using engine-out data would be significant. For example, three major U.S. operators indicated that there would be a total annual cost of $10M. A number of other U.S. operators were unable to provide a cost estimate associated with engine-out accountability, but indicated that they would be affected by the proposal. One Canadian operator reported cost estimates of between $22M and $48M, when the prospective rule was examined across three years of operation (These figures considered the payload reduction during the period 1996-1998).[8]

None of the cost estimates included any associated costs, such as downstream scheduling problems; additional crew and aircraft positioning costs, hotels and meals for stranded passengers, and lost goodwill, etc.

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[8] See Appendix A for FAA/JAA HARMONIZATION REVENUE LOSSES (WP 13-2)

To be clear, the cost of creating data is comparable for all-engines and engine-out, however the operational costs of contaminated runway accountability are significantly higher for engine-out.

17 - If advisory or interpretive material is to be submitted, document the advisory or interpretive guidelines. If disagreement exists, document the disagreement.

Non-consensus on this issue is indicated by the submittal of two separate proposals – this report and Working Group Report 4.

18 - Does the HWG wish to answer any supplementary questions specific to this project? [If the HWG can think of customized questions or concerns relevant to this project, please present the questions and the HWG answers and comments here.

No.

19 – Does the HWG want to review the draft NPRM prior to publication in the Federal Register?

Yes.

The Working Group did not reach consensus on this issue. The following Working Group members support the all-engine standard for FAA operators for takeoff from contaminated runways as proposed in this report.

Name	Organization
Virginia Eades, Wayne Soverns	Trans World Airlines, ATA Representative
Richard Elliott, Paul Schmid, C. J. Turner	The Boeing Company
Christian Camihort	Dassault Aviation
Jon Quail, Gordon Gregg, Gene Nimetz	Air Canada
Fred Jones	Air Transport Association of Canada

APPENDIX A

FAA/JAA HARMONIZATION REVENUE LOSSES **WP 13-2**

(Annual Cost in Millions of Dollars)

AIRLINE	NBR OF A/C	DRAFT AC 120-XXX	>15º BANK	LINE UP	WET RWY	LINE UP & WET	ENGOUT SLUSH	TOTAL
TW	183	4.7	*	3.0	2.1	7.1	***4.7	16.5
AA	650	A	11.1	8.0	6.0	16.3	A	27.4
UA	570	ICAO	N/A	A	5.0	5.0	A	5.0
DL	570	A	N/A	2.0	A	2.0	A	2.0
NW	415	A	*	1.9	4.0	6.0	0.34	6.34
CO	364	A	**	5.0	4.0	9.0	3.5	12.5
US	420	ICAO	?	8.0	4.0	12.0	P	12.0
WN	300	.6	N/A	A	A	A	A	.6
HP	115	A	N/A	A	A	A	A	
UPS	250	ICAO	N/A	A	N	N	P	
ATA	48	?	?	N	N	N	A	
FX	301	ICAO	N/A	2.0	3.5	5.5	A	5.5
AC	158	ICAO	*	A	N	N	P	
CP	80	ICAO	?	N	N	N	39.1	39.1
TOTAL		5.3	11.1	29.9	28.6	62.9	47.64	126.94

* Could not service St. Maarten. Cost unknown.

** RNO new service. Cost unknown.

*** Slush cost updated with new Boeing/Douglas engine out data.

A = already accounting
N = no figures available, not accounting
P = done on part of the fleet
N/A = not applicable - no situation exists

Economic Impact of Performance Harmonization Issues

Titles across the top of the chart indicate items considered at Jan 12, 1999 ATA meetings as having an economic impact. An additional item is mentioned in the text of this report.

DRAFT AC 120-xxx Use of draft AC 120-xxx for obstacle clearance analysis. Two airlines (TW and WN) use the FAR splay currently. Others use the draft AC unless noted as "ICAO".

>15° BANK Use of JAR OPS 1.495 turn procedure limitations. JARs state "bank angles of greater than 15 degrees are not allowed". Further, special approval (a temporary non-renewable approval) "to increase bank angles for not more than 20 degrees between 200 feet and 400 feet, or not more than 30 degrees above 400 feet" can be granted.

LINE UP Inclusion of line-up distance in runway analysis. Assume a 90 degree turn and line up at minimum distance.

WET RWY Accounting for wet runways with engine out. Required by JAR OPS, not required by FARs. If wet runway data is published in the AFM, most US airlines will account for it

ENG OUT SLUSH Use of engine-out data for contaminated runways. Not required in the FARs. However most US airlines make some accounting for this condition

TOTAL the combined estimate of Draft AC, Bank Angle, Line-up and Slush.

TW - Trans World Airlines

TWA estimates the economic impact their operation would be:.

1	Use of draft AC 120-xxx for obstacles	4.7 million
2.	St. Maarten could not be serviced	
3.	Accountability for line-up distance	3 million
4.	Wet runway accountability (20% wet days assumed)	2.1 million
	Wet runway done for 717	
5.	Contaminated runway with engine out	4.7 million
	Currently uses data about half way between all engine and engine out	
6.	Line-up and wet combined	7.1 million
7.	Combined draft AC, Line-up, wet and contaminated	16.5 million
	TWA operates 183 aircraft	

Economic impact issues were discussed at recent ATA meeting. The following are figures given by other airlines.

AA - American Airlines

Turn procedure limitations	11.1 million
Accountability for line up distance previously reported	8 million
Wet runway accountability (20% wet days assumed)	6 million
Wet runway and line-up distance combined	16.3 million
AA already uses the draft AC obstacle splay	
Combined total	27.4 million
AA operates about 650 aircraft	

UA - United Airlines

Doing line-up distance
Only Reno affected by bank angle greater than 15º. B727 payload reduced to 91% load factor. However,average load factor is 75%, so economic impact is zero.
Estimate of wet runway accountability 4 to 6 million
Using engine out data for contaminated runways.
Doing ICAO splay
UA operates 570 aircraft.

DL - Delta Airlines

Accountability for line-up distance 2 million
Already do wet runway with engine out
Use draft AC120-xxx for obstacle
Delta operates 570 aircraft.

NW - Northwest Airlines

Uses draft AC120-xxx for obstacle clearance
Could not service St Maarten
Accountability for line-up distance 1.9 million
Wet runway accountability (15% wet days assumed)4 million
Contaminated runways with engine out $340,000
(currently not done on DC9 and DC10 fleet)
Wet and line-up combined estimated at 6 million
which would be understated. 6 million
Combined total 6.34 million
NW operates about 375 aircraft

CO - Continental Airlines

Line-up distance 5 million
Doing wet runway accountability on 737NG and 777.
Estimate for doing other fleets 4 million
This could be decreased by analysis of using a different flap setting.
Contaminated runways do engine out for DC-10
cost of doing other fleets 3.5 million
Combined total 12.5 million
CO operates 350 aircraft.

US - US Airways

US is making a change in the takeoff system. They have gone to the SABER system just a month ago. Under
their old system they accounted for wet runway on Airbus only. Estimate an increase of 4 Million to do for all aircraft.
Line-up distance was not accounted for and estimate an increase of 8 Million to do that.
Already using ICAO splay.

Using engine out contaminated runway data on Airbus only. However they are moving toward that with the remaining aircraft.
Combined total 12 million
US Airways operates about 420 aircraft.

WN - Southwest Airlines
Already accounting for line-up distance
Already accounting for wet runway
Uses FAA obstacle splay converting draft AC estimate $600,000
SWA operates about 300 aircraft

HP - America West

Using the Draft AC
Not using bank angles greater than 15º
Accounting for line-up distance
Accounting for west runway
Doing engine out contaminated runways
HP operates 115 aircraft

UPS -United Parcel Service

Already doing line-up distance
Do engine out on contaminated runway for some aircraft. No estimate on those not done.
(Manufacturer's data incomplete and inconsistent.)
Do not do wet runway with engine out. UPS is having programs developed to provide wet runway data
One time cost $250,000
Already use the ICAO splay
Major concern is dispatching to icy runways and accounting for icy landing data
Estimated yearly cost 10.8 Million
UPS operates 250 aircraft.

ATA - American Trans Air

Do contaminated runway with engine out.
Still assessing wet runway and line-up. Midway Airport will have severe penalties, however.
ATA operates 48 aircraft. This will increase to 60 by end of '99.

FX - Federal Express

Line-up distance	2 million.
Using ICAO splay	
No wet runway corrections, estimate	3.5 million
Combined total	5.5 million
Fed Ex operates 301 aircraft.	

AC - Air Canada

Uses a fixed line-up distance of 200 ft regardless of aircraft type.
Could not service St Maarten with JAR OPS turn requirements
No wet runway corrections, no estimate of cost.
Uses engine out data for contaminated runway except on DC9 and B767 aircraft,
Uses the ICAO splay.
Changes in line-up distance accountability and use of draft AC120-xxx would be an economic benefit to AC.
AC operates 158 aircraft.

CP - Canadian Airlines

Do not do line-up distance, no estimate
Do not do wet runway. Think the penalties will be on 737-200 and 767-200 fleets.
Doing engine out on contaminated runways for Airbus and 747 fleets.
Estimate the cost of doing engine out contaminated runway accountability will fall on 737-200 and 767-300 fleets. Looked at the cost if it had been done in 1996, 1997 and 1998 and would have been a 22 million to 48 million cost for those years. CA already is doing all engine contemned runway accountability. The figures are not the delta differences. CA did mention the penalty on the 737-200 (?) raises from 8,000 pounds of weight loss to 20,000 pounds between all engine and engine out.
Using the ICAO splay.
CP operates 80 aircraft.

United Airlines noted that the above economic impact studies only considered the loss of revenue due to reduction in weight. It did not consider other costs such as putting up passengers in a hotel, food, etc.